THE PROGRESS OF THE TELEGRAPH *

V.

WE now continue our description of Wheatstone's electrical "Jacquard."

The rapid sequence of currents passed into the line-wire by the "Transmitter" are automatically recorded at the distant station by means of an apparatus called the "Receiver," or printer, which marks upon a continuous paper ribbon, as it passes through the instrument, the "dot" and "dash" code of the Morse alphabet, corresponding to the holes in the perforated Jacquard ribbon, as rapidly as the sequence of currents can be passed into the line. Two forms of this receiving instrument may be noticed: one shown in Fig. 22, in which the "dot" and "dash" code is represented by dots upon the paper ribbon upon either side of a central line, the lower line of dots being read as "dashes" and the upper line as "dots." The paper ribbon, mechanically advanced forward through the machine in a continuous manner, is passed under a shallow dish containing ink or other marking fluid. Two fine small holes are made through the bottom of this reservoir, in a position to correspond with the dots to be printed upon the ribbon as it passes underneath the reservoir. By reason of capillary attraction, the ink is prevented from passing through these apertures. Two electro-magnets, one on either side of the ink-reservoir, actuate two needles, which are adjusted so as to be depressed by the action of the current, and, dipping into the reservoir, pass into the holes, and carry a small dot

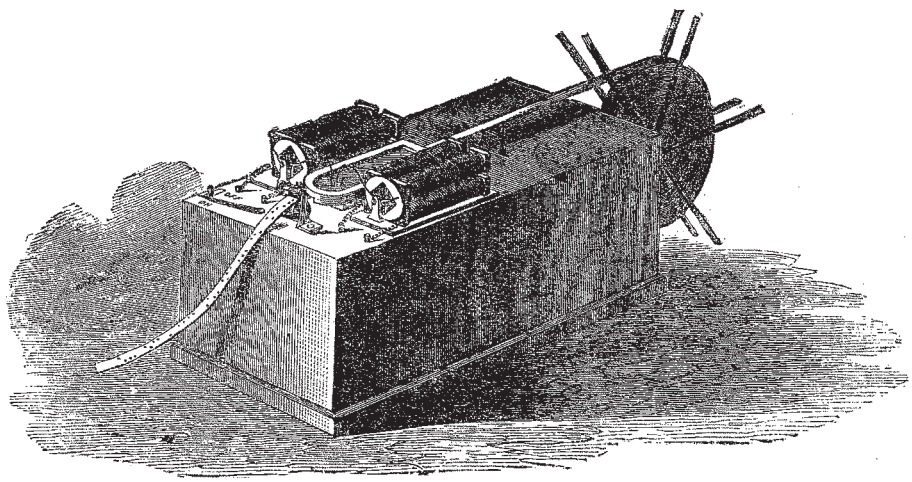

FIG. 22.—Wheatstone's "dot" automatic "Printer."

of ink through on to the paper ribbon; thus the mark is printed as a "dot" or "dash," according as the respective needle is depressed without any friction or mechanical resistance beyond that of the needle dipping into the ink held in the capillary tubes. The electro-magnet coils are so arranged that only the respective needles are acted upon by the currents as they flow from the positive or negative poles of the battery. The "dot" printing is shown at Fig. 23.

In the other form of "Printer" the Morse code is printed in "dot" and "dash" characters, the groups and sequence of groups forming the letters and words exactly corresponding with the dot and dash perforations in the Jacquard ribbon. Fig. 24 is the automatic printing upon this system from the perforated ribbon shown at Fig. 20. Capillary attraction is here again made use of, only in a different manner. A small inking disc of metal mounted upon a delicately poised axle capable of a slight angular oscillation in a lateral direction, according as it is influenced by the to-and-fro motion of a permanent mag-

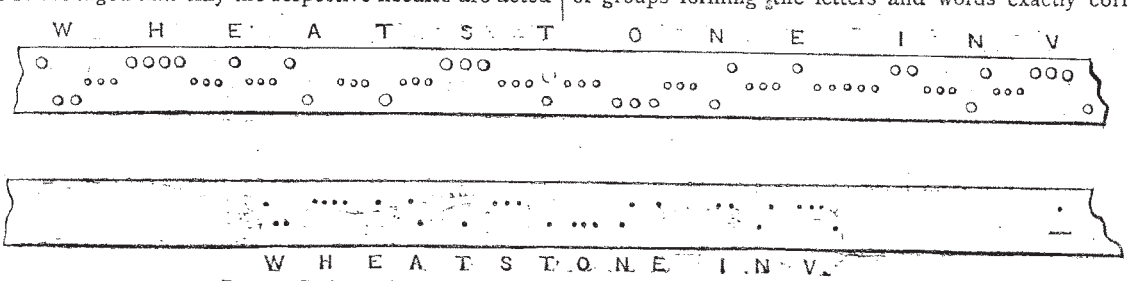

FIG. 23.—Perforated Jacquard ribbon and printing by the "dot" automatic system.

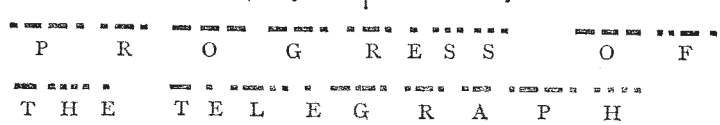

FIG. 24.—An "electric loom," or automatic telegraph printed message from the perforated paper ribbon (Fig. 20.)

netic armature when acted upon by the alternate currents passed into the line from the "Transmitter," is made to rotate rapidly by the same mechanical means that advances the paper ribbon. This little rotating inker is placed close to the surface of the paper ribbon, so that on receiving a lateral motion in one direction its edge is pressed against the paper and removed from it by an

* Continued from vol. xi. p. 512.

opposite motion, while in its neutral position it is free from contact. Thus contact with the paper will produce marks, either dot or dash, according as the inking contact is either momentary or of a sensible duration; the contrary movement producing the spacing between the printed marks. Now, as the currents from the Jacquard ribbon (Fig. 20) are passed at equal intervals and in alternate directions, the spacings between the signals will be automatically regular; the "dash" being the effect of the retention of the magnetic armature acting on the inking disc for double the time of the "dot" by reason of the grouping of the perforations to form the "dash," giving a longer duration without a reversal of the current being passed into the circuit. The arrangement for supplying ink to the little revolving inking disc is simple and effective. A metal wheel, having its edge cut into a V shape, is kept revolving in a dish of ink, and by capillary attraction this V groove is kept constantly filled with ink, and thus the periphery of the little inking disc which revolves in this groove of ink is without any rubbing friction kept constantly supplied with the proper amount of ink to continuously record the rapid motion of the armature as the currents flow from the transmitter into the wire. It is by these very simple means that Wheatstone has produced his high-speed printer, at once an accurate recorder and a telegraphic necessity in these days of special press-transmissions to the chief commercial centres of the United Kingdom.

In order to realise the great value of the automatic high-speed system upon extended lines of telegraphic transmissions, it is only necessary to compare the speed of the Morse apparatus on lines of a given length with that of the automatic electric Jacquard weaver. With an apparatus combining such celerity of transmission and recording powers, it becomes necessary to adopt a special system for the despatch and receipt of intelligence; to economise manual labour, and utilise the capacity of the wire to the greatest extent. Messages are therefore passed into the machine for transmission along the wire in groups; that is to say, on a circuit of 300 miles in length, twelve messages will be perforated upon a continuous ribbon and sent through the "transmitter" at the same time, and *vice versâ*. Employing a wire of a capacity known as No. 8 Birmingham wire gauge over this distance, four

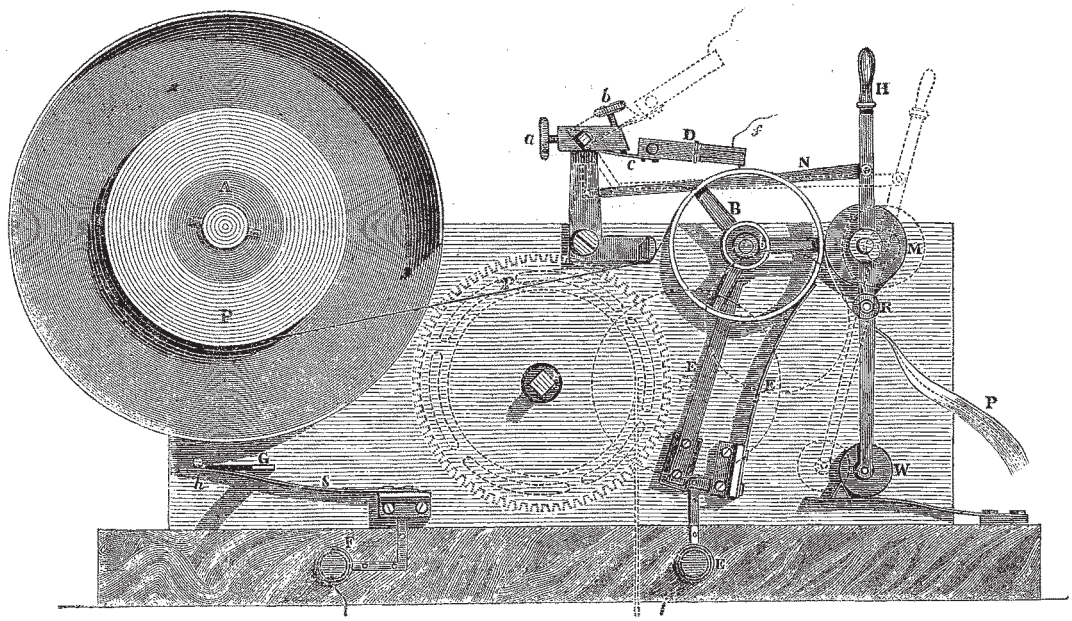

FIG. 25.—Alexander Bain's Automatic Chemical Printing Telegraph, 1846.

distinct groups consisting of twelve messages of thirty words each can be forwarded, and three similar groups received, in an hour; equivalent to eighty-four messages of thirty words each, and with the average of five letters to a word, a total of 12,600 letters, or an average of 210 letters per minute, equivalent to forty-two words per minute, with all the necessary formalities and acknowledgments in addition. Such a speed may be maintained in moderately fine weather, and requires a staff of five clerks at both the receiving and transmitting stations; namely, two for perforating the messages on to the paper ribbon, two for writing or translating, and one for the working of the apparatus in sending acknowledgments and signals for repetitions, &c. When dealing with parliamentary and newspaper despatches, a much higher speed can be obtained, first because there is no necessity for grouping the messages, and secondly because, as a rule, the transmissions are only in one direction, either as wholly received or forwarded messages, which circumstances greatly reduce the initial delay in the transmission. With a No. 4 wire gauge between Aberdeen and London, forty words may be reached, and with a No. 6 wire between Edinburgh and London fifty words, between Newcastle-upon-Tyne and London sixty words, and between Glasgow and Liverpool 120 words may be recorded. The shorter the length of the line, the greater the speed obtained. A very rapid form of a chemical automatic printing telegraph has been designed in America, based upon Alexander Bain's chemical automatic printer, 1846. This American chemical automatic machine has sent and printed, under favourable conditions, intelligence between Washington and New York, a distance of 282 miles, at a speed of 1,050 words or about 5,250 letters per minute, at which rate the apparatus required ten perforators, thirteen copyists, and two instrument-operators to keep the circuit supplied and the transmissions transcribed for general circulation. How far such a speed can be profitably employed for telegraphic purposes remains to be developed. It is quite possible to transmit intelligence beyond a profitable speed, for, irrespective of the difficulty of always commanding a sufficient amount of intelligence to keep the apparatus fully employed, the vast staff of manipulators necessary to ensure the preparation of the Jacquard ribbon, and translation of the symbolic

code into language, must always form a very important element in the commercial value of all high-speed arrangements, when the speed is beyond that of the public requirements of the circuit.

Alexander Bain's chemical printing telegraph, invented in 1846, of which this American automatic machine is only a modernised adaptation, is shown at Fig. 25. It combined methods of arranging, transmitting, and receiving electrical telegraph communications, in which mechanically-composed communications were transmitted through electric circuits, and received by chemically prepared surfaces, both apparatus being kept in motion by mechanical means, without the aid of magnets. The apparatus consisted of a frame containing a driving power by which a rotatory motion was imparted to the metal drum B, placed in connection with the earth by means of the contact springs E E. The paper strip P P, chemically prepared by being immersed in a solution of sulphuric acid and prussiate of potass to receive the sequence of currents transmitted through the wire from the "transmitter," is wound upon the drum A, and is drawn forward over the revolving earth contact B at a uniform speed by reason of the pressure of the break roller M, which may, whenever the paper is not required to advance, be withdrawn by the lever H working on the centre R, and kept in position either way by the action of the spring roller W. An insulated metallic style D, in connection with the line wire *f*, and furnished with the necessary screw adjustments *a*, *b*, *c*, is arranged to press uniformly upon the chemically-prepared paper as it passes over the earth drum B. The style D can also be removed from pressing contact with the paper ribbon when required, as indicated by the dotted outline. When therefore the style D is passing over the surface of the prepared paper, and electric currents are passed through the line wire *f* from the distant station, the electric circuit will be completed through the paper ribbon P, and the metallic drum B, with the earth E, and in the passage of the current, the iron in the chemical solution is decomposed and a dark blue mark becomes visible upon the paper corresponding in length to the duration of the current; so that if the Jacquard ribbon at the distant station is perforated into the necessary length of holes to represent the sequences of dots and dashes in the Morse code, to form letters and words, the chemical decomposition from the style D will be an accurate replica of the distant message in the "dot" and "dash" symbols. It was thus that in 1846 Alexander Bain, the clever and ingenious Edinburgh watchmaker, originated a system of electric automatic chemical Jacquard printing, which even at the present day is scarcely understood, and which in all probability is left to American skill to develop. Its extreme simplicity and wonderful chemical sensibility speak volumes in its favour, provided, as has been already observed, such extreme velocities can be profitably worked in this small planet of ours.

(*To be continued.*)

RECENT FRENCH MATHEMATICAL PUBLICATIONS

M. CHASLES is reprinting a new edition of his celebrated work, "Aperçu Historique:" the first part has been already issued. The learned geometer has made no alteration in the book, which was written many years ago and long before he had been led to assert frivolous claims in favour of Pascal, and no allusion is made to the Newton forgeries. The whole work will cost no more than 20*s*., only one-fourth of the selling price of the old edition, which has for some time been very scarce.

There has been in France a revival of interest in the subject of imaginary quantities. Thus, a translation by Laisant of Bellavitis's "Calcul des Equipollences" has been published lately. It is regarded by Bellavitis himself as a system of quaternions in one plane, and thus is somewhat analogous to the efforts made in England to popularise the great Hamilton's theories. But it is only a partial effort, as Bellavitis's results do not admit of being generalised so as to apply to solid geometry.

M. Hoüel, whose name is connected with the publication of a series of useful tables, will very likely be more successful in this respect, as he is preparing a "Theory of Quaternions."

The same mathematician has edited a reprint of a work on the "Geometrical Representation of Imaginary Quantities," originally published in 1806 by Argand. One of his objects appears to have been to defend the rights of his illustrious countryman. But they are not so disregarded in England as the author seems to suppose.

The third and concluding part of the new edition of Briot and Bouquet's "Theory of Elliptic Functions" has appeared. It is quite a new book, though professing to be a second edition of the small octavo volume which became rapidly so popular amongst mathematicians.

M. Paul de Saint Robert has published a third and concluding volume of his interesting "Memoirs," several of which were published in English in the *Philosophical Magazine*. Amongst these valuable papers, which are here reprinted, we must not neglect to notice the "New formulæ for determining the altitude from barometric observations." These formulæ embody the results of the observations taken by Mr. James Glaisher in some of his aëronautical ascents. M. Saint Robert in this way improves the well-known Laplace's formulæ, which were based only on the Ramont's observations taken in the Pyrenean ranges; and takes into account the carefully observed facts which had been neglected in England.

NOTES

THE Committee on the Loan Exhibition of Scientific Apparatus met in the Science Schools at the South Kensington Museum yesterday. It has been determined to postpone the exhibition till March 1876, and from the strength of the Committee appointed and the interest taken in the scheme by scientific societies, we may expect the collection to be unique.

IT will be of interest to geologists to know that Capt. Feilden, R.A., the naturalist of the senior ship of the Arctic Expedition, in addition to making the observations on the birds of Northern Europe, Malta, India, China, and North America, which will be found scattered through the pages of the "Zoologist" and quoted by Prof. Newton and Messrs. Sharpe and Dresser in various works, has given much attention to the palæontology of many of these countries, especially to the Miocenes of Malta and the Faroe islands, and the Mastodon beds of South Carolina. By permission of Prof. Ramsay, V.P.R.S., the Director-General of H.M. Geological Survey, Capt. Feilden has also recently been shown the method employed in carrying out geological field-work by that Survey, by one of its staff, Mr. De Rance.

THE French Academy of Sciences, at its sitting on Monday last, received the report of M. Fleuriais, the head of the Transit of Venus Expedition to Pekin. The observations were very satisfactory indeed, the four contacts having been photographed with complete success. The weather was very boisterous all the day long, but at the four important moments the observers were favoured by a total absence of clouds. They succeeded in executing a map of Pekin, in spite of the obstacles placed in their way by the natives. The dimensions are 8,000 metres by 7,000, and the length of the walls is 33 kilometres. The instruments set up by the missionaries last century are in perfect